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(8-89)

United States Government **Department of Energy**

Bonneville Power Administration

memorandum

DATE: May 26, 2006

REPLY TO ATTN OF: TOM/PPOC2-2

SUBJECT: Performance Validation and Noise Injection Staged Tests

TO: John Haner – TOM/PPO2-2
Peggy Olds – TOT/DITT2
Richard Ellison –TOD/DITT1
T. Snodgrass – TOV/MEAD

1. Summary and Objectives

The Bonneville Power Administration (**BPA**) is planning comprehensive probing tests of WECC system dynamics under spring and summer conditions. These tests will be performed in coordination with WECC technical groups such as the DMWG and M&VWG, and they are nominally scheduled for June, 2006 and August 2006 respectively. The tests will include the following staged events:

- Energization of the Chief Joseph dynamic brake
- Insertion of brief sine waves by modulation of the Pacific HVDC Intertie
- Insertion of sustained random noise by modulation of the Pacific HVDC Intertie

The main objectives of these tests include the following:

A. Obtain seasonal benchmarks for dynamic performance of the WECC system
B. Develop comparative data to evaluate and refine the realism of WECC modeling tools
C. Refine and validate methods that identify power system dynamics with minimal or no use of probing signals

The spring test sequence is planned for June 13, 2006 subject to PDCI availability. If system conditions do not allow testing on this day than the test will be scheduled for an alternate day suitable for performing the test. The summer test sequence is planned for August 22, 2006. Dates may be revised by System Operations to meet system requirements.

Close examination of system behavior will be made before and throughout the test to confirm that system conditions are suitable for testing, and that the test is proceeding as expected. WECC members having a PDC StreamReader are invited to participate in this, and to use associated provided spectral analysis software to observe frequency domain signatures for their service areas. Extended data access at the California ISO and the Pacific Northwest National Laboratory permits almost total backup to BPA for this aspect of testing.

WAMS data from these tests will be recorded automatically. However, it is necessary that the operators of the measurement facilities assure that the recording systems are ready for this, and that the owners of the data be aware that copies of the records will be requested for analysis. Such activities will be coordinated through the WECC Disturbance Monitoring Work Group.

Previous versions of these tests are described in WECC documents such [1,2] and a concise summary of tests performed in September 2005 is available as [3]. Distinguishing features of the tests in 2005 and 2006 are a strong focus on Objective C, plus greatly improved instrumentation and software for achieving this objective.

2. Operating Conditions Required For Tests

Operating Conditions for Test Series

- Power system operation normal, with no impediments to safe testing
- Pacific HVDC Intertie (**PDCI**) in bipolar operation with North to South flow
- PDCI power transfer above 800 MW and less than 2950 MW
- Langdon – Cranbrook 500 kV line in service.

3. Test Precautions and Termination Procedure

If at any time the Test Observers, security coordinators or system operators identify conditions under which the tests should not continue then the Test Director will suspend the test sequence until those conditions are no longer present.

Reasons for suspending, modifying, or terminating the test sequence include but are not limited to the following:

- System emergency exists within the WECC
- Interconnections operating outside normal limits
- Undamped or unacceptable levels of system oscillations
- Facility operator deems that facility is unsafe for test, or that the test procedure is interfering with proper operation of that facility
- Test procedure is conflicting with a peak in operator workload

4. Sequence of Test Events

The list below shows specific test events to be performed. Times for these test events are in Pacific Daylight (Advanced) Time (PDT).

The time and the duration of specific test events can be adjusted, during the test itself, to minimize interference with smooth operation of the power system. A description of each playback file is given on page 12.

Test Series A: Calibration Checks on PDCI Probing Signals

Step A1 [9:10] Calibration check on MSF-20/6/17 for ±5 MW noise probing to determine HVDC pole response. Noise bandwidth will be 20 Hz. Adjust scaling of Probing Signal Generator (PSG) if needed.

Step A2 [9:15] Apply MSF-20/6/17 for ±5 MW noise probing to determine HVDC pole response. Expected duration is 5 minutes or less.

Step A3 [9:20] Calibration check on MSF-1/6/136 for ±10 MW noise probing of inter-area modes. Adjust PSG scaling if needed.

Step A4 [9:25] Apply MSF-1/6/136 for ±10 MW noise probing of inter-area modes. Expected duration is 10 minutes, but additional time may be needed for coordination of real-time observations at remote locations.

Step A5 [9:40] Apply PbfSM2 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.25 Hz.

Step A6 [9:42] Apply PbfSM3 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.70 Hz.

Step A7 [9:44] Apply PbfSM4 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.42 Hz.

Test Series B: Cross Validation of Probing Methods

Step B1 [13:10] Insertion B1 of the Chief Joseph Dynamic Brake

Step B2 [13:15] Insertion B2 of the Chief Joseph Dynamic Brake, five minutes after insertion B1

Step B3 [13:20] Apply a ±20 MW MSF-1/6/136 for a duration of 20 minutes. Additional time may be needed if powerflow shifts or discrete control actions are noted during the test interval.

Step B4 [13:45] Apply PbfSM2 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.25 Hz.

Step B5 [13:47] Apply PbfSM4 for single-mode probing ±125 MW. Waveform will be three cycles of a sine wave at 0.42 Hz.

Test Series C: Noise Probing

Step C1 [14:10] Measurement of ambient noise conditions

Step C2 [14:30] Apply a ±20 MW MSF-1/6/136 for a duration of 9 periods (~20 minutes).

Test Series D: Noise Probing

Step D1 [15:10] Measurement of ambient noise conditions

Step D2 [15:15] Apply a ±20 MW MSF-1/6/136 for a duration of 15 periods (~35 minutes).

Test Series E: Noise Probing

Step E1 [16:10] Measurement of ambient noise conditions

Step E2 [16:15] Apply a ±20 MW MSF-1/6/68 for a duration of 30 periods (~35 minutes).

5. Test Coordinator and Responsibilities

Test coordination will be as follows:

1. Jim Burns will schedule the tests through the BPA outage dispatcher.
2. Jim Burns (BPA technical staff) will post proposed test dates on the BPA Web page.
3. The day before each test, BPA will send a message on the WECC Net notifying of the tests.
4. If there are concerns about abnormal system conditions, BPA dispatcher should be contacted as early as possible to cancel a test. The test will be resumed the next hour after the system returns to normal.
5. The probing signal will be injected by an operator of Celilo converter station. The operator will clear with the BPA dispatcher before the signal injection.

A listing of contact persons and test observers with phone numbers and e-mail addresses is provided in attachment.

6. Measurement Requirements

WAMS data from these tests will be recorded automatically. However, it is necessary that the operators of the measurement facilities assure that the recording systems are ready for this, and that the owners of the data be aware that copies of the records will be requested for analysis.

Required measurements for Test Series

- Continuous PDC, PMU and PPSM recording required at BPA locations.
- Continuous PDC, PMU and PPSM recordings highly desirable at all other WECC locations.
- Continuous 240 sps recording with the Celilo PPSM required.

Required facilities for real-time analysis

A key objective in the proposed tests is to "Refine and validate methods that identify power system dynamics with minimal or no use of probing signals." Key real-time resources for this are PDC StreamReaders, located at key locations, plus the spectral analysis tool provided as an add-on for the PDC StreamReader. Other documents refer to this tool as Dynamic Signal Analyzer (**DSA**), and that terminology is used here.

It is essential that DSA analysis be immediately available to the Test Director throughout the test. StreamReaders with DSA are essential at Dittmer and highly desirable at at Celilo and PNNL Richland. It is also suggested that California ISO and other organizations that have PDC StreamReaders operate them during the test period.

7. Test Preparations

The Celilo Probing Signal Generator (PSG) will be furnished with a suitable menu of playback files. These playback files will be verified on site for MW scaling and other characteristics before their use in long term probing. BPA & PNNL will work together on PSG matters.

8. Illustrations of Applied Test Signals

The following figures from the Test Plan Comprehensive Report are illustrative of the system response to signals that will be applied during this test.

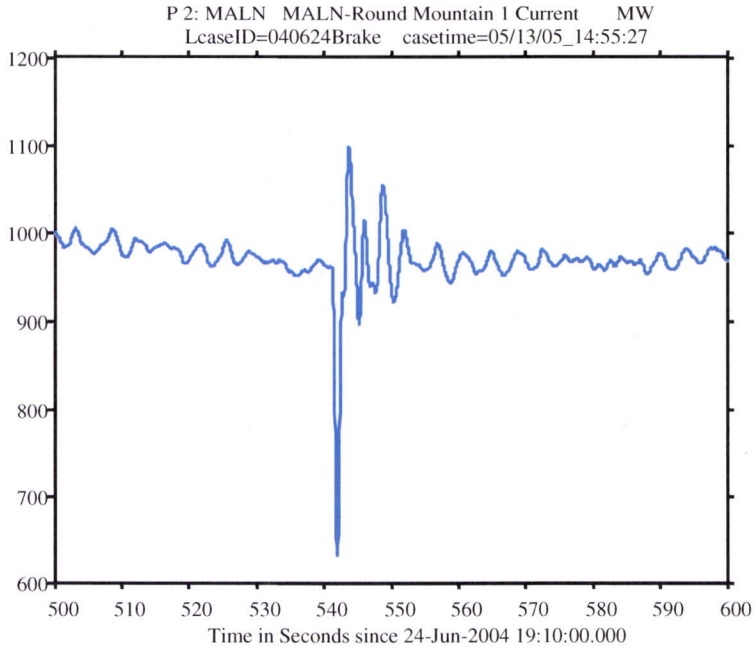

Figure 8.1 Chief Joseph Brake Application June 24, 2004.

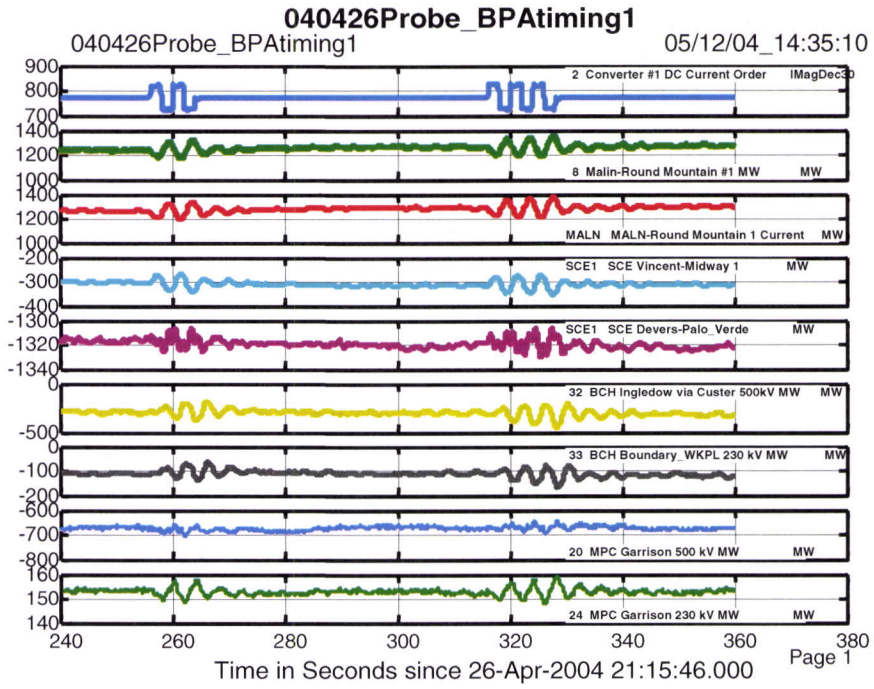

Figure 8.2. Wide area response to single mode probing on April 26, 2004

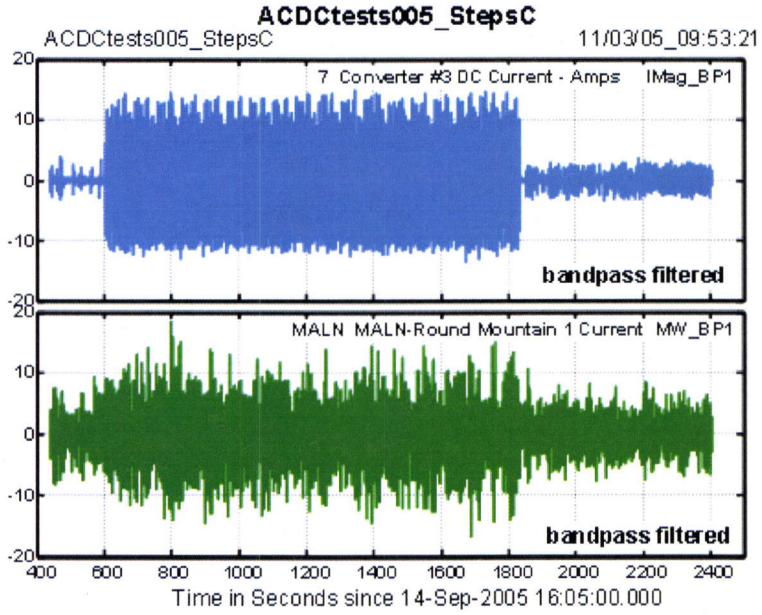

Figure 8.3 Response of Malin-Round Mountain MW to low level noise probing

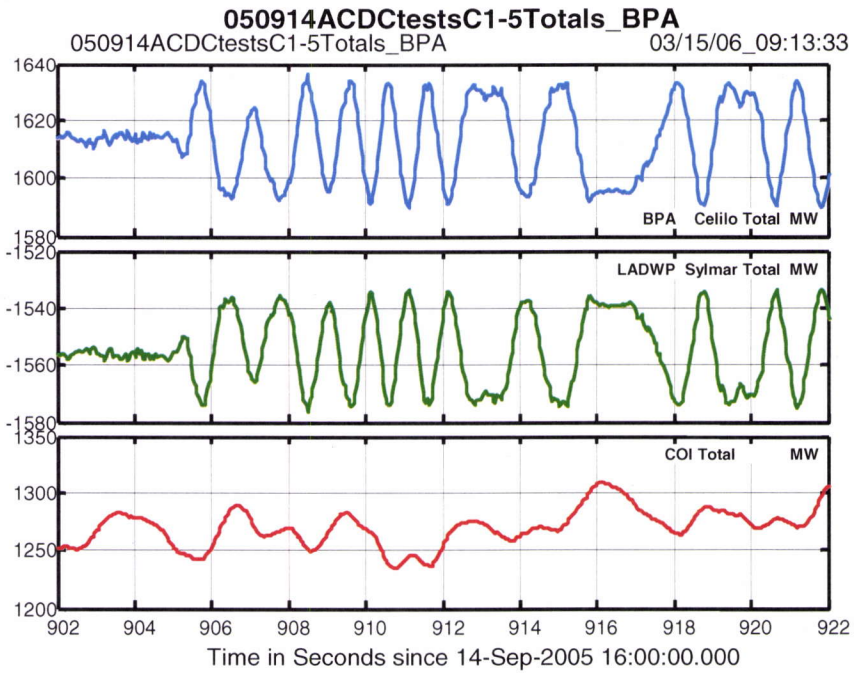

Figure 8.4. Startup of low level noise modulation, test step C3 on 09/14/05

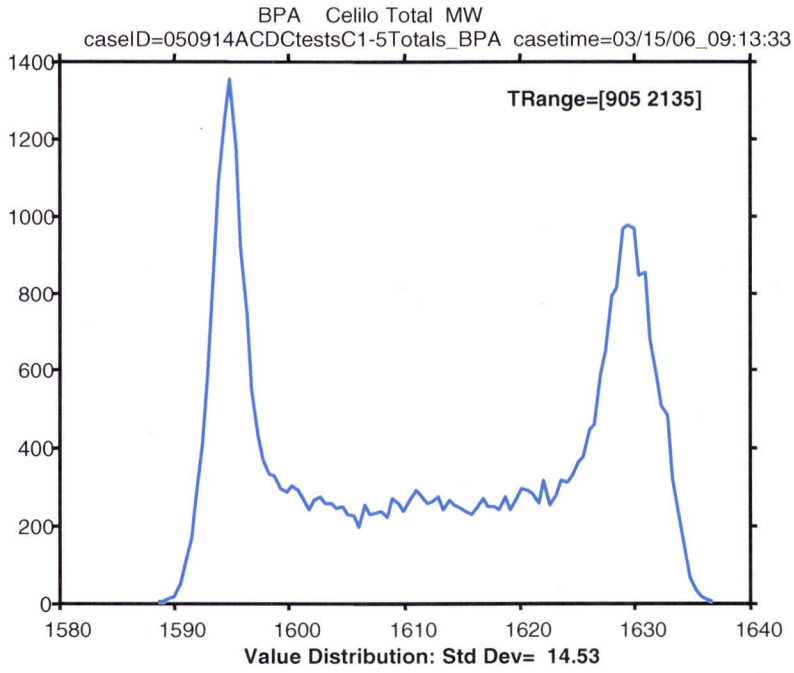

Figure 8.5. Histogram for Celilo AC MW response to low level noise probing, test step C3 on 09/14/05

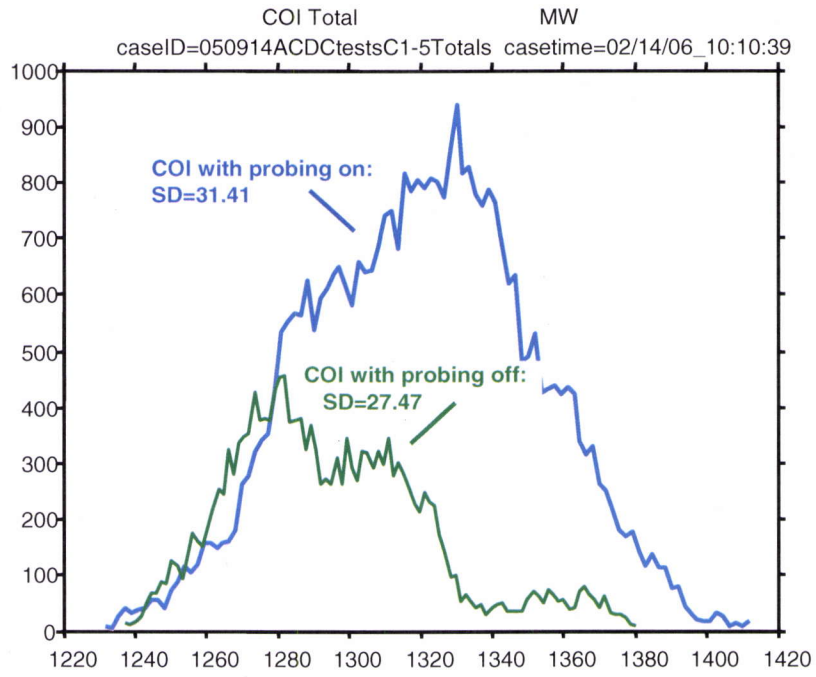

Figure 8.6. Histogram for COI MW response to low level noise probing, test step C3 on 09/14/05

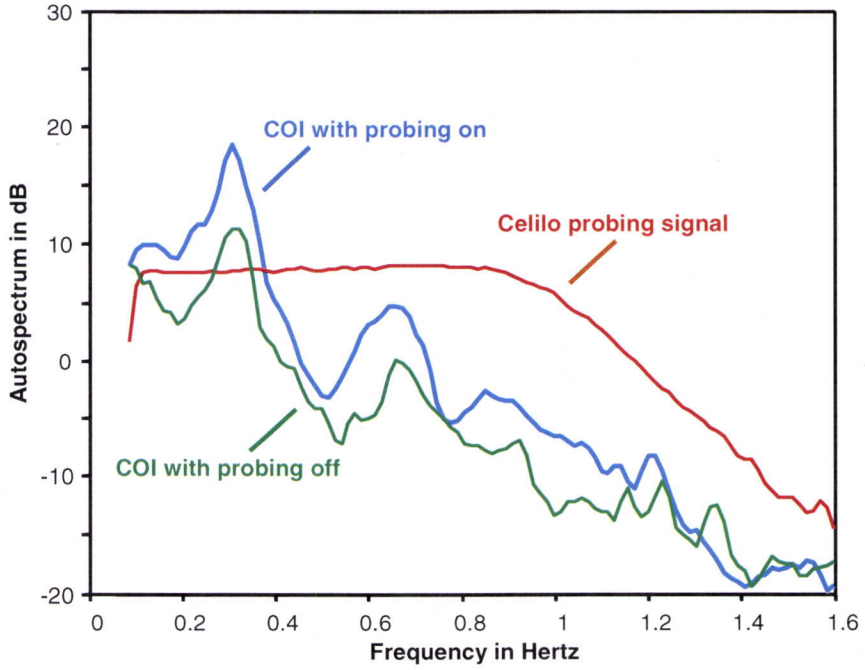

Figure 8.7. Key autospectra for level noise probing, test step C3 on 09/14/05

Additonal information on the test signals and system response is provided in [3] and in various other documents cited there.

9. Test Approvals

Submitted by:

William A. Mittelstadt – TOM
Dmitry Kosterev - TOM

Approved: R. Shanayek Date: May-23-06
Manager, Support Services for Network Planning – TOM

Approved: Rod Ulch Date: 5-24-06
Manager, Technical Operations –TOT

Approved: Stephen Holcomb Date: 5-24-06
FOR Manager, Dittmer Dispatch - TOD

Approved: [signature] **Date:** 5/24/06
Manager, Munro Dispatch - TOV

cc:
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B. Silverstein – TO/DITT2
M. Rodrigues – TOP/PPO2-2
J. Haner – TOM/PPO2-2
R. Ellison – TOD/DITT1
P. Olds - TOT/DITT2
T. Snodgrass - TOV/MEAD
B.McManus – TOT/DITT2
J. Burns - TOT/DITT1
J. Gronquist – TOT/DITT2
D. Kosterev – TOM/PPO2-2
G. Keenan – TOM/PPO2-2
W. Mittelstadt – TOM/PPO2-2
M. Overeem – TFRS/CELILO
J. Barton - TFRS/CELILO
W. Litzenberger – TNP-PPO2-1
L. Anderson – TNSD-PPO2-1
K. Martin – TNT/AMPN 1
J. Bernhardsen – TO/DITT2 - NWSC
Marty O'Rourke (SPC District Engineer) - TFSS-SICKLER
Rodger Allen (SPC Craftsman) - TFSS-CHIEF JOSEPH
Dittmer Outage Dispatcher – TOD/DITT1
Dittmer System Dispatcher – TOD/DITT1 (2 copies)
Official File - TOP (ED-21-15)

WAMittelstadt/DKosterev 5/18/06 (Noise Injection Test Plan051806.doc)

Attachment 1

Coordination and Contact Persons List

Contact	Utility	Function	Phone	Email
Jim Burns	**BPA**	**Test Director**	**(360) 418-2331**	jwburns@bpa.gov
Chief Dispachers		**All WECC dispachers**		chiefdis@wscc.com
Senior Operator	BPA	**Celilo**	541-296-3615 X-300	
BPA Dispatcher	BPA	Dittmer	(360) 418-2281	
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Bill Mittelstadt	BPA	System Planning (PVTF)	(360) 418-8647	wmittelstadt@bpa.gov
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Dave Hawkins	CAISO	PWG Chairman		dhawkins@caiso.com
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Travis Smith	DWP	IPP DSM		

Attachment 2

Playback File Table

The following table describes various types of noise signal definitions, some of which will be used in the test.

File Name	Test	Type	Band Width or Frequency	Amplitude
MSF-20/6/17	A	Multi-sine fitted	20 Hz 6^{th} filter	+/- 5 MW
MSF-1/6/68	A,E	Multi-sine fitted	1 Hz 6^{th} fit	+/- 10 MW (5 x 2 multiplier)
MSF/1/6/136	B,C,D	Multisine fitted	1 Hz 6^{th} order filter	+/- 20 MW (5 x 4 multiplier)
PbfSM1		Square single mode	3 cycle 0.25 Hz	+/- 125 MW
PbfSM2	A,B	Sine single mode	3 cycle 0.25 Hz	+/- 125 MW
PbfSM3	A	Sine single mode	3 cycle 0.7 Hz	+/- 125 MW
PbfSM4	A,B	Sine single mode	3 cycle 0.42 Hz	+/- 125 MW

[1] **Interim Report on the Model Validation Tests of June 7, 2000 -- Part 1: Oscillatory Dynamics**, principal investigator J. F. Hauer. WSCC Performance Validation Task Force (PVTF) of the Modeling and Validation Work Group, October 26, 2000.

[2] Integrated Monitor Facilities for the Western Power System: WAMS Analysis in 2005, J. F. Hauer, W. A. Mittelstadt, K. E. Martin, J. W. Burns, and Harry Lee. Interim report of the WECC Disturbance Monitoring Work Group, December 2005.

[3] September 2005 Staged System Tests for Validation of WECC System Performance and Modeling—Summary Report, J. F. Hauer et al. WAMS Working Note, March 21, 2006.